



# **Closeout Report**

## **Director's Progress Review of the USCMS Phase 2 Upgrade Project**

**September 17, 2015**

September 17, 2015

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## **1.0 Introduction**

A Director's Progress Review of the CMS Phase 2 Upgrade Project was conducted on September 17, 2015. This review is to inform the laboratory about the state of the overall planning, to provide guidance as to readiness to proceed to the CD-0 stage, and to help prepare for presentation of the projects plans to the DOE and NSF. The charge included a list of specific questions, which are answered in this report. The Committee's assessment is documented in the body of this closeout presentation.

This presentation is broken down into three basic sections. The first section is the Committee's overall assessment. The second section has the answers to the review charge questions, which include comments on some aspects of the project. The last section consists of Appendices that contain the reference materials for this review. Appendix A shows the charge for this review and Appendix B is the agenda that was followed. The review team contact information is included in Appendix C.

## **2.0 Overall Assessment**

The plan presented by the US CMS upgrade project is well aligned with the overall CMS upgrades. The US plan is well motivated by the physics opportunities presented by the HL-LHC. The US CMS upgrades are of central importance for the CMS detector and are fundamental for its physics performance. The high-granularity calorimeter and the track trigger are advancing the state of the art and represent an investment towards the future of HEP detectors.

At this pre-CD-0 stage, the project plan is reasonable, but many technical challenges remain to be addressed.

### **3.0 Charge Questions**

#### **3.1 Design and Scope.**

##### **3.1.1 Is the scope of the preliminary proposed US contributions well-aligned to the overall upgrade plan for CMS, and consistent with the goals outlined in the Particle Physics Project Prioritization Panel(P5)?**

Yes. The US CMS upgrade project scope has been developed within the context of the overall CMS upgrade plan, which in turn is fully consistent with the goals of the P5 plan.

##### **3.1.2 Has the project identified a reasonable scope for which the DOE will be responsible, considering the early stage of the project planning?**

The scope presented by the project appears reasonable, if ambitious. Our evaluations by L2 subsystem are the following:

The muon system scope is quite reasonable and is based on extensive experience and the cost and schedule estimates appear adequate for this stage.

The barrel calorimeter upgrade project is relatively incremental and straightforward.

The new high-granularity end cap calorimeter is an ambitious project which advances the state of the art and potentially adds substantial new physics capability such as precision vertex timing and the tracking and separation of showers within the calorimeter. Given that the HGCAL relies on new technology, the Project should carefully review risk and contingency estimates.

The outer tracker upgrade is well defined and is largely based on past experience. The cost and schedule were developed bottoms-up and relied on the experience of Run 1 design and construction. These estimates appear adequate for this stage.

The new forward pixel system has a reference design which provides a sound basis for developing the preliminary and final designs. Some challenging R&D will be required, particularly for the very high-eta region. The cost and schedule estimates are based on the Run 1 and Phase-1 FPIX experience and appear adequate for this stage.

The track trigger is an ambitious project, which is essential for the CMS program in order to maintain the required physics capability. Currently there are three candidate technologies for implementing the track trigger and detailed plans for USCMS cannot be made until a technology choice is made. This choice will not be made until the time of CD-1 at the earliest.

The calorimeter trigger, muon trigger, and global trigger are well defined and based on past experience. The track correlator is dependent on the track trigger. The interface with the track trigger has been established such that progress can be made on the track correlator.

**3.1.3 Have the performance requirements been defined, or is there a credible plan for doing so?**

The Technical Proposal presents a design which addresses the physics goals of CMS at the HL-LHC. A full set of detailed requirements to constrain the system designs is being developed as the collaboration works toward the TDR and US CMS works toward CD-1.

**3.1.4 Is there an adequate plan for independent design reviews?**

For the moment, there is no plan for independent design reviews. However, the project manager is aware of need to develop a plan for such reviews.

**3.1.5 Are the designs described in the CMS Technical Proposal adequately developed to support the preliminary cost and schedule estimates?**

Yes.

**3.1.6 Is the R&D needed to design the upgrades well-coordinated, funded at the appropriate level, and credible? Are the projected resources sufficient to complete the designs and R&D, and are these resources likely to be available when needed?**

The R&D is well coordinated with the overall CMS project and aims at addressing the major technical issues.

Anticipated R&D/OPC funding is a potential concern. Currently there is a 10%-20% shortfall between the planned R&D/OPC budget need and the amount thought to be available from the funding sources identified so far.

It would be good to separate the R&D from the OPC funding, and make lists of tasks that must be completed in each category and establish priorities.

The large step in R&D/OPC funding between FY17 and FY18 could be smoothed if adequate funding from the operations program and from Fermilab can be utilized in FY17. It is our understanding that this is the plan.

Assuming adequate funding is available to complete the R&D, the required resources are available.

### **3.2 Cost and Schedule.**

#### **3.2.7 Are the cost and schedule estimates at a level consistent with the current status of the project?**

Given the pre-CD-0 status of the project, the cost and schedule estimates are reasonable.

#### **3.2.8 Are the cost and schedule estimates credible and realistic, and is the final project likely to fit within the proposed cost range?**

The cost of the project has been established based on a funding profile presented by the DOE and a budget target for the NSF component. The scope presented by the project appears reasonable, if ambitious relative to this budget.

The USCMS schedule presented is consistent with the planned LHC operations schedule and is plausibly achievable. However, there are several areas of potential concern, to which the project should pay attention. These include: The track trigger, which is quite challenging and for which a technology decision has not yet been made and the end-cap calorimeter, for which a radiation hard ASIC must be designed by non-US partners whose development and delivery could impact the US schedule.

#### **3.2.9 Is the proposed US scope of work consistent with the projected available budget given the DOE preliminary profile and a likely NSF contribution and profile?**

The scope presented by the project appears reasonable, if ambitious.

#### **3.2.10 Does the scheduling strategy fit with other major projects at Fermilab?**

The information necessary to make this determination is available to the USCMS project management in terms of profiles of Fermilab resources needed, but the exercise of comparing the required and available resources at Fermilab has not been done yet. It is planned to address this issue in the coming months.



### **3.3 Management.**

#### **3.3.11 Are the management teams, including partnering institutions, sufficiently defined and staffed considering the early stage of the project, and do they possess the requisite expertise and experience?**

The management team is in place to level 2 and some level 3 managers have been identified. The management team members are well experienced in their areas of responsibility.

#### **3.3.12 Is the management team appropriately organized and staffed to initiate the CMS Phase 2 upgrade planning activities?**

The current staffing level is just adequate for the current state. However, to advance the planning and prepare for CD-1, substantially more project management staff will be needed. The project is on track to complete the staffing of the level 3 management structure. It is important to add project office staff including project controls personnel well in advance of CD-1 and this is an area in which Fermilab could provide support.

#### **3.3.13 Have the systems for managing interfaces between stakeholders been defined and are they appropriate?**

For the moment there is no formal system in place within the USCMS upgrade project for managing interfaces. The USCMS project manager is aware of the need to address this.

#### **3.3.14 Is there a plan to develop management plan documents that are sufficient to manage the program?**

Yes, the USCMS management knows that such documents must be prepared in advance of CD-1.

#### **3.3.15 Is procurement planning sufficiently detailed and coordinated across the organizations involved for this stage of the project?**

Procurements during the R&D phase are being done through the operations program. More advanced procurement planning will be done in the context of preparation for CD-1.

September 17, 2015

## **4.0 Appendices**

Charge

Agenda

Reviewers Contact Information

Appendix A

**Charge**

Director's Progress Review of the USCMS Phase 2 Upgrade Project  
September 17, 2015

08-Sep-2015

**To:** Mike Lindgren, Chief Project Officer

**From:** Nigel Lockyer, Director

**Subject:** Director's Progress Review of the CMS Phase 2 upgrade project

Please organize and conduct a Director's Progress Review to assess the progress to date and plans for execution of the CMS Phase 2 upgrades. Upgrades to the CMS detector at the LHC will be needed for the future High Luminosity LHC running period, scheduled to start in 2026 and last about 10 years. These upgrades will be installed during Long Shutdown 3, which is scheduled to last for 30 months, starting in January 2024. The DOE has given a preliminary budget profile scenario. The project anticipates receiving Critical Decision 0 approval within the next year, so has not yet formally entered into the DOE project management system. This review is to inform the laboratory about the state of the overall planning, to provide guidance as to readiness to proceed to the CD-0 stage, and to help prepare for presentation of the projects plans to the DOE and NSF.

The focus of this review is to understand proposed project scope, R&D plans, cost range, schedule, management preparedness, and any other issues impacting readiness for beginning execution of the program. The review committee should respond to the following questions:

1. **Design and Scope.** Is the scope of the preliminary proposed US contributions well-aligned to the overall upgrade plan for CMS, and consistent with the goals outlined in the Particle Physics Project Prioritization Panel(P5)? Has the project identified a reasonable scope for which the DOE will be responsible, considering the early stage of the project planning? Have the performance requirements been defined, or is there a credible plan for doing so? Is there an adequate plan for independent design reviews? Are the designs described in the CMS Technical Proposal adequately developed to support the preliminary cost and schedule estimates? Is the R&D needed to design the upgrades well coordinated, funded at the appropriate level, and credible? Are the projected resources sufficient to complete the designs and R&D, and are these resources likely to be available when needed?
2. **Cost and Schedule.** Are the cost and schedule estimates at a level consistent with the current status of the project? Are the cost and schedule estimates credible and realistic, and is the final project likely to fit within the proposed cost range? Is the proposed US scope of work consistent with the projected available budget given the DOE preliminary profile and a likely NSF contribution and profile? Does the scheduling strategy fit with other major projects at Fermilab?
3. **Management.** Are the management teams, including partnering institutions, sufficiently defined and staffed considering the early stage of the project, and do they possess the requisite expertise and experience? Is the management team appropriately organized and staffed to initiate the CMS Phase 2 upgrade planning activities? Have the systems for managing interfaces between stakeholders been defined and are they appropriate? Is there a plan to develop management plan documents that are sufficient to manage the program? Is procurement planning sufficiently detailed and coordinated across the organizations involved for this stage of the project?

The committee is asked to present a draft of their report at the review closeout and to issue the final report within two weeks of the review's conclusion.

September 17, 2015

Nigel Lockyer  
Director, Fermi National Accelerator Laboratory

cc:

J. Lykken  
G. Bock  
E. Gottschalk  
V. O'Dell  
P. McBride  
M. Kaducak

## Appendix B

**Agenda**Director's Progress Review of the USCMS Phase 2 Upgrade Project  
September 17, 2015**Thursday, September 17, 2015, Comitium (WH2SE)**

8:00 – 8:30	AM	30	Closed Executive Session	Review Team
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**Plenary Sessions – One West**

8:30 – 8:40	AM	10	Welcome	Joe Lykken/Patty McBride
8:40 – 9:00	AM	20	Overview of CMS HL-LHC Upgrades	Anders Ryd
9:00 – 9:30	AM	30	The CMS HL-LHC Project and US contributions	Vivian O'Dell
9:30 – 10:10	AM	40	Tracker	Christopher Hill/Karl Ecklund
10:10 – 10:30	AM	20	Barrel Cal	Colin Jessup

**10:30 – 10:45 AM 15 BREAK – Outside of One West (WH1W)**

10:45 – 11:15	AM	30	Endcap Cal	Jeremiah Mans
11:15 – 11:40	AM	25	Muons	Alexei Safonov
11:40 – 12:00	PM	20	Trigger	Jeffrey Berryhill

**12:00 – 1:00 PM 60 LUNCH – 2<sup>nd</sup> Floor Crossover**  
Committee Executive Session (Comitium)

1:00 – 3:00	PM	120	Parallel Sessions	
			Tracker/Track Trigger – One East (WH1E)	
			Cal – Black Hole (WH2NW)	
			Muons/Trigger – Snake Pit (WH2NE)	
			Management and Cost/Schedule – Comitium (WH2SE)	

**3:00 – 3:15 PM 15 BREAK – Outside of Comitium (WH2SE)**

3:15 – 5:00	PM	105	Executive Session/Report Writing – Comitium (WH2SE)
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5:00 – 5:30	PM	30	Closeout Session – One West (WH1W)
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Appendix C

**Reviewers' Contact Information**

Director's Progress Review of the USCMS Phase 2 Upgrade Project  
September 17, 2015

**Chairperson**

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**Observer**

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